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Floristic inventory of the habitats of the endangered montane grassland bird Nilgiri Pipit (*Anthus nilghiriensis* Sharpe) at Palani Hills and Nilgiri Hills of southern Western Ghats, India

Introduction

The Nilgiri Pipit (*Anthus nilghiriensis* Sharpe) is endemic to higher elevation grasslands in the southern Western Ghats of Kerala and Tamil Nadu (Alström, Mild, 2003). It is endangered, highly range-restricted, non-migratory montane grassland bird with short distance movements within its habitat (Robin et al., 2014; Grewal et al., 2016; Lele et al., 2020). There are about 40 species of Pipits (genus *Anthus* Bech.) found globally, in which 13 are recorded from India (Praveen, 2016). The Nilgiri Pipit is a medium sized Pipit and can be differentiated from other Pipits by having prominent broad, dark brown streaks on the head, back, breast, upper belly and flanks (Ali, Ripley, 1987; Rasmussen, Anderton, 2005; Robin et al., 2014) and lacks malar stripe and patch (Grimmett et al., 2016). Nilgiri Pipit differs from closely allied widespread Paddyfield Pipit (*Anthus rufulus* Vieillot) by having shorter tail and richer brown streaks (Grewal et al.,

2016). The Nilgiri Pipits are mainly insectivorous and forages on ground in grass for insects and small seeds (Ali, Ripley, 1987; Tyler, 2004; Sangha, 2011; Grimmett et al., 2016).

The Shola grassland ecosystem of southern Western Ghats has unique altitude, species composition and diversity, distribution pattern and hosts several endemic plants in their niches (Arigela et al., 2019). In the Western Ghats, 55–80% montane grasslands have been converted to commercial and non-commercial plantations (Robin et al., 2014). About 66% of native grasslands and about 31% of native forest loss recorded in last 4 decades exclusively at Palani Hills (Arasumani et al., 2018). Montane habitats are facing extreme threat from anthropogenic pressure (Pounds, 1999; Sekercioglu, 2008) and even micro-climatic changes in these habitats devastate the species diversity (Martin, 2001). Robin *et al.* (2014) elevated red list status of the Nilgiri Pipit from vulnerable to endangered by considering B2 with B2a and B2b ii & iii of the IUCN Red List criteria for an endangered species. Lele et al., (2020) explicated the factors which influenced the area of occurrence and occupancy of the habitat specific bird Nilgiri Pipit and is negatively influenced by the presence of invasive woody vegetation. We also observed the negative influence of other invasive herbs, subshrubs and shrubs. By considering all the above threats factors, plant inventories in the habitats of the endangered bird Nigiri Pipit (Fig. 1 – Appendix 1) is a prerequisite to conserve the threatened species. The aim of this study was to prepare the comprehensive list of plants in the high altitude grasslands to conserve the landscapes and biodiversity in it.

Materials and methods

During the field explorations under various projects between 2012 and 2021, authors explored the grassland vegetation at Palani Hills and Nilgiri Hills of Kerala and Tamil Nadu states respectively. The special emphasis was given to high altitude or montane grasslands of these areas, as they occupied huge areas with great species diversity and interspersed with the Shola forests. During the explorations in these grasslands, Pied Bushchat (*Saxicola caprata* Linnaeus), Nilgiri Tahr (*Nilgiritragus hylocrius* Ogilby), Nilgiri Pipit and shola grassland vegetation were observed and photographed with high resolution cameras. The Nilgiri Pipit is identified by the expert determinations and available relevant literature (Ali, 2002; Grewal, 2016; Grimmett, 2016). The Nilgiri Pipits are restricted only to montane grasslands 1600–2600 m altitude and we collected the plant specimens from these localities with the field numbers and GPS coordinates. The plant specimens were identified with the help of relevant taxonomic literature (Matthew,

1999; Kabeer & Nair, 2009), type specimens, protologues and other herbarium specimens housed at different herbaria. Botanical nomenclature and system of classification was used according to APG-IV and zoological according Linnaean Taxonomy and IOC World Bird List Version 12.1.

Results and discussion

Based on the field studies, the Nilgiri Pipit was found in the *Andropogon polyptychos-Eulalia phaeothrix-Arundinella purpurea* grasslands (Kabeer, Nair, 2009) at 1800–2300 m altitude of Sispara and Mukurthi National Park of Nilgiri Hills. In the Palani Hills, the Nilgiri Pipit was found in the *Chrysopogon-Cymbopogon-Tripogon* grasslands of Palamputtur and Vadakownji-Pannaikkadu ghat road (Zeronium Grasslands) 1800–2000 m, *Chrysopogon-Cymbopogon* grasslands of Kukkal, Perumalmalai and Vattakanal at 1700–2250 m, *Arundinella-Chrysopogon* grasslands of Ibex Peak and Vembadi Peak at 1800–2500 m (Arigela et al., 2019). A total of 108 plant species belonging to 32 families were identified in the habitats of the Nilgiri Pipit (Tab. 1 – Appendix 2) and few plants specimens deposited at MH. Among them, 44 are endemic (Singh et al, 2015), 17 are invasive (Reddy, 2008) and 47 are native species with moderate to vast geographical distribution. Among 20 grass taxa, dominant grasses in the habitats of the Nilgiri Pipit are *Andropogon polyptychos, Arundinella vaginata, Chrysopogon asper* and *C. nodulibarbis* (Fig. 2 – Appendix 1).

Few species like *Anaphalis neelgerryana, Eriocaulon robustum, Hedyotis hirsutissima, H. verticillaris, Strobilanthes lanata, S. wightiana, Rubus racemosus* are restricted to the Sispara and some other areas of Nilgiri Hills. *Brachycorythis splendida* occurs only in the grasslands of Palani Hills. *Andropogon polyptychos* is the dominant grassland species at Sispara and other areas of Nilgiri Hills, and it is highly preferred grass by Nilgiri Pipit. In the Zeronium grasslands (Vadakownji-Pannaikkadu grasslands) of Palani Hills, the dominant grasses are *Cymbopogon flexuosus* and *Tripogon pungens* mixed with some small patches of *Andropogon polyptychos* and is near to the cultivated fields, also heavily invaded by *Acacia* spp., *Ageratina adenophora*, *Eucalyptus* spp. and *Pteridium aquilinum*. Therefore, this area is not preferred by the Nilgiri Pipit and their population is very less here, but we found good population of Paddyfield Pipit.

In these montane grasslands, the existence of the endemic fauna is interdependent on the existence of the endemic flora (Fig. 3, 4 – Appendix 1). The Nilgiri Pipit prefers the marshy slopes (Robin, 2014) and valleys (Vinod, 2007) in these grasslands for nesting and feeding. A

few rushes (species of *Juncus*) intermixed with the grasses in the nesting sites were identified. Species of *Acacia*, *Eucalyptus* and *Pinus* were introduced at Palani Hills by British Forest Officers for timber and fuelwood (Matthew, 1999), but now some species of these genera naturalized and spreading in the grasslands, Shola forests and other forests and become serious threat for the local flora and fauna (Fig. 5 – Appendix 1). In the Nilgiris, invasion of grasslands can be seen by tree species of *Acacia*. The naturalized tree species of these genera are vigorously invading the grasslands and Shola forests of Palani Hills and Nilgiri Hills, and altering their size and functions. Apart from these tree species, few exotic shrub species like *Cytisus scoparius* and *Ulex europaeus* are invading the Nilgiri Pipit habitats at Nilgiris. Fire prone invasive fern *Pteridium aquilinum*, invasive herbs *Erigeron karvinskianus* and *Ageratina adenophora* occurred in all these grasslands areas. Apart from these, few more invasive plants species in these grasslands are found (Tab. 1 – Appendix 1).

Conclusions

Based on the field explorations and identification of plants, we have concluded the landscape alterations in greater extent by the invasive alien plant species and naturalized plantations in the habitats of Nilgiri Pipit at southern Western Ghats. Highly productive grassland habitat loss is a major threat to endemic grassland bird Nilgiri Pipit and other native flora & fauna. Existence of this bird is uncertain in the near future due to the invasion of alien plant species in their habitat. We suggest that, selective seasonal removal of these invasive plants and naturalized plantation species (Species of *Acacica*, *Eucalyptus* and *Pinus*) before their blooming and seed setting at Nilgiri Hills, Palni Hills and controlling the anthropogenic pressure on Palni Hills will restore the original montane grassland habitats of these endemic plant and animal species.

Conflict of interest

The author declares no conflict of interest related to this article.

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Appendix 1

Fig. 1. Nilgiri Pipit: in the grassland (A–D), on the Shola tree *Rhododendron nilagiricum* (E), near the nesting site (F), on *Acacia mearnsii* (G), on *Pinus roxburghii* (H) (Photo. Ravi Kiran Arigela)

Fig 2. Major grasses in the habitats of the Nilgiri Pipit: *Andropogon polyptychos* (A–B), *Arundinella vaginata* (C–D), *Chrysopogon asper* (E–F), *Chrysopogon nodulibarbis* (G–H) (Photo. Ravi Kiran Arigela)

Fig 3. Endemic plants in the habitats of the Nilgiri Pipit: *Hedyotis hirsutissima* (A), *Rubus racemosus* (B), *Anaphalis neelgerryana* (C), *Rhododendron nilagiricum* (D), *Brachycorythis splendida* (E), *Eriocaulon robustum* (F), *Habenaria longicornu* (G),. *Hedyotis verticillaris* (H) (Photo. Althaf Ahamed Kabeer and Ravi Kiran Arigela)

Fig 4. Endemic plants in the habitats of the Nilgiri Pipit: *Anaphalis beddomei* (A), *Anaphalis travancorica* (B), *Anaphalis bournei* (C), *Murdannia dimorpha* (D), *Habenaria elliptica* (E), *Hedyotis swertioides* (F), *Strobilanthes wightiana* (G), *Kalanchoe grandiflora* (H) (Photo. Ravi Kiran Arigela)

Fig 5. Invasive plants species threats to the montane grasslands: *Ulex europaeus* (A), *Cytisus scoparius* (B), *Pteridium aquilinum* (C), *Ageratina Adenophora* (D), *Eucalyptus* spp. (E), *Pinus* spp. (F), *Acacia decurrens* (G), *Acacia mearnsii* (H) (Photo. Althaf Ahamed Kabeer and Ravi Kiran Arigela)

Appendix 2

Table 1. Vegetation in the habitats of the Nilgiri Pipit at Palani Hills and Nilgiri Hills

Si. No.	Scientific Name	Family	Location	Status
1	*Acacia dealbata* Link	Mimosaceae	Nilgiri, Palani	Invasive
2	*Acacia decurrens* (J.C. Wendl.) Willd.	Mimosaceae	Nilgiri, Palani	Invasive
3	*Acacia mearnsii* De Wild.	Mimosaceae	Nilgiri, Palani	Invasive
4	*Aerides crispa* Lindl.	Orchidaceae	Nilgiri, Palani	Endemic
5	*Ageratina adenophora* (Spreng.) R.M. King & H. Rob.	Asteraceae	Nilgiri, Palani, Sispara	Invasive
6	*Agrostis peninsularis* Hook. f.	Poaceae	Nilgiri, Palani, Sispara	Endemic
7	*Anaphalis beddomei* Hook. f.	Asteraceae	Nilgiri, Palani, Sispara	Endemic
8	*Anaphalis bournei* Fyson	Asteraceae	Nilgiri, Palani, Sispara	Endemic
9	*Anaphalis meeboldii* W.W. Sm.	Asteraceae	Palani	Endemic
10	*Anaphalis neelgerryana* DC.	Asteraceae	Nilgiri, Sispara	Endemic
11	*Anaphalis travancorica* W.W. Sm.	Asteraceae	Nilgiri, Palani	Endemic
12	*Anaphalis wightiana* DC.	Asteraceae	Nilgiri, Palani, Sispara	Endemic
13	*Andropogon polyptychos* Steud.	Poaceae	Nilgiri, Palani, Sispara	Native
14	*Anisochilus argenteus* Gamble	Lamiaceae	Nilgiri, Palani, Sispara	Endemic
15	*Arundinella mesophylla* Nees ex Steud.	Poaceae	Nilgiri, Palani, Sispara	Endemic
16	*Arundinella purpurea* Hochst. ex Steud.	Poaceae	Nilgiri, Palani, Sispara	Native
17	*Arundinella vaginata* Bor	Poaceae	Nilgiri, Palani, Sispara	Endemic
18	*Brachiaria semiundulata* (Hochst. ex A. Rich.) Stapf	Poaceae	Nilgiri, Palani, Sispara	Native
19	*Brachycorythis iantha* (Wight) Summerh.	Orchidaceae	Nilgiri, Palani	Endemic
20	*Brachycorythis splendida* Summerh.	Orchidaceae	Palani	Endemic
21	*Centella asiatica* (L.) Urb.	Apiaceae	Nilgiri, Palani, Sispara	Native
22	*Chrysopogon asper* B. Heyne ex Blatt. & McCann	Poaceae	Nilgiri, Palani, Sispara	Endemic
23	*Chrysopogon nodulibarbis* (Hochst. ex Steud.) Henrard	Poaceae	Nilgiri, Palani, Sispara	Native
24	*Coelachne simpliciuscula* (Wight & Arn. ex Steud.) Munro ex Benth.	Poaceae	Nilgiri, Palani, Sispara	Native
25	*Crotalaria fysonii* Dunn	Fabaceae	Nilgiri, Palani, Sispara	Endemic
26	*Crotalaria scabrella* Wight & Arn.	Fabaceae	Nilgiri, Palani, Sispara	Native
27	*Cyanotis arachnoidea* C.B. Clarke	Commelinaceae	Nilgiri, Palani, Sispara	Native
28	*Cymbopogon flexuosus* (Nees ex Steud.) W. Watson	Poaceae	Nilgiri, Palani, Sispara	Native
29	*Cytisus scoparius* (L.) Link	Fabaceae	Nilgiri, Palani, Sispara	Invasive
30	*Desmodium microphyllum* (Thunb.) DC.	Fabaceae	Nilgiri, Palani, Sispara	Native
31	*Dodonaea viscosa* Jacq.	Sapindaceae	Nilgiri, Palani, Sispara	Native
32	*Drosera peltata* Thunb.	Droseraceae	Nilgiri, Palani, Sispara	Native
33	*Emilia javanica* (Burm. f.) C.B. Rob.	Asteraceae	Nilgiri, Palani, Sispara	Native
34	*Erigeron karvinskianus* DC.	Asteraceae	Nilgiri, Palani, Sispara	Invasive
35	*Eriocaulon brownianum* Mart.	Eriocaulaceae	Nilgiri, Palani, Sispara	Native
36	*Eriocaulon robustum* Steud.	Eriocaulaceae	Nilgiri, Sispara	Endemic
37	*Eucalyptus citriodora* Hook.	Myrtaceae	Nilgiri, Palani	Invasive
38	*Eucalyptus globulus* Labill.	Myrtaceae	Nilgiri, Palani	Invasive
39	*Eucalyptus grandis* W. Hill ex Maiden	Myrtaceae	Nilgiri, Palani	Invasive
40	*Eucalyptus saligna* Sm.	Myrtaceae	Nilgiri, Palani	Invasive
41	*Eulalia phaeothrix* (Hack.) Kuntze	Poaceae	Nilgiri, Palani, Sispara	Native
42	*Exacum wightianum* Arn.	Gentianaceae	Nilgiri, Palani, Sispara	Endemic
43	*Fimbristylis kingii* Gamble ex Boeckeler	Cyperaceae	Nilgiri, Palani, Sispara	Endemic

44	*Fimbristylis salbundia* (Nees) Kunth	Cyperaceae	Nilgiri, Palani, Sispara	Native
45	*Fimbristylis uliginosa* Hochst. ex Steud.	Cyperaceae	Nilgiri, Palani	Endemic
46	*Gaultheria fragrantissima* Wall.	Ericaceae	Nilgiri, Palani, Sispara	Native
47	*Habenaria digitata* Lindl.	Orchidaceae	Nilgiri, Palani, Sispara	Native
48	*Habenaria elliptica* Wight	Orchidaceae	Nilgiri, Palani, Sispara	Endemic
49	*Habenaria longicornu* Lindl.	Orchidaceae	Nilgiri, Palani, Sispara	Endemic
50	*Habenaria rariflora* A. Rich.	Orchidaceae	Nilgiri, Palani, Sispara	Endemic
51	*Hedyotis articularis* R. Br. ex Wight & Arn.	Rubiaceae	Nilgiri, Palani, Sispara	Endemic
52	*Hedyotis hirsutissima* Bedd.	Rubiaceae	Nilgiri, Sispara	Endemic
53	*Hedyotis swertioides* Hook. f.	Rubiaceae	Nilgiri, Palani, Sispara	Endemic
54	*Hedyotis verticillaris* Wall. ex Wight & Arn.	Rubiaceae	Nilgiri, Sispara	Endemic
55	*Helichrysum buddleioides* DC. ex Wight	Asteraceae	Nilgiri, Sispara	Native
56	*Heracleum rigens* Wall. ex DC.	Apiaceae	Nilgiri, Palani, Sispara	Endemic
57	*Hypericum mysurense* Wall. ex Wight & Arn.	Hypericaceae	Nilgiri, Palani, Sispara	Native
58	*Indigofera pedicellata* Wight & Arn.	Fabaceae	Nilgiri, Palani, Sispara	Native
59	*Isachne kunthiana* (Wight & Arn. ex Steud.) Miq.	Poaceae	Nilgiri, Palani, Sispara	Native
60	*Ischaemum ciliare* Retz.	Poaceae	Nilgiri, Palani, Sispara	Native
61	*Ischaemum polystachyum* J. Presl	Poaceae	Nilgiri, Palani, Sispara	Native
62	*Juncus bufonius* L.	Juncaceae	Nilgiri, Palani, Sispara	Native
63	*Juncus effusus* L.	Juncaceae	Nilgiri, Palani, Sispara	Native
64	*Juncus inflexus* L.	Juncaceae	Nilgiri, Palani, Sispara	Native
65	*Juncus prismatocarpus* R. Br. subsp. *leschenaultii* (Gay ex Laharpe) Kirschner	Juncaceae	Nilgiri, Palani, Sispara	Native
66	*Kalanchoe grandiflora* Wight & Arn.	Crassulaceae	Nilgiri, Palani, Sispara	Endemic
67	*Kalanchoe lanceolata* (Forssk.) Pers.	Crassulaceae	Nilgiri, Palani, Sispara	Native
68	*Lantana camara* L.	Verbenaceae	Palani	Invasive
69	*Laurembergia coccinea* (Blume) Kanitz	Haloragaceae	Nilgiri, Palani, Sispara	Native
70	*Leucas helianthemifolia* Desf.	Lamiaceae	Nilgiri, Palani, Sispara	Endemic
71	*Leucas hirta* (B.Heyne ex Roth) Spreng.	Lamiaceae	Nilgiri, Palani, Sispara	Endemic
72	*Linum mysorense* B. Heyne ex Benth.	Linaceae	Nilgiri, Palani, Sispara	Native
73	*Malaxis densiflora* (A. Rich.) Kuntze	Orchidaceae	Nilgiri, Palani, Sispara	Native
74	*Murdannia dimorpha* (Dalzell) G. Brückn.	Commelinaceae	Nilgiri, Palani, Sispara	Endemic
75	*Osbeckia aspera* Blume	Melastomataceae	Nilgiri, Palani, Sispara	Native
76	*Osbeckia gracilis* Bedd.	Melastomataceae	Nilgiri, Palani, Sispara	Endemic
77	*Osbeckia leschenaultiana* DC.	Melastomataceae	Nilgiri, Palani, Sispara	Endemic
78	*Phyllanthus narayanswamii* Gamble	Euphorbiaceae	Nilgiri, Palani	Endemic
79	*Pimpinella candolleana* Wight & Arn.	Apiaceae	Nilgiri, Palani, Sispara	Native
80	*Pinus patula* Schiede ex Schltdl. & Cham.	Pinaceae	Palani	Invasive
81	*Pinus pseudostrobus* Lindl.	Pinaceae	Palani	Invasive
82	*Pinus radiata* D. Don	Pinaceae	Palani	Invasive
83	*Pinus roxburghii* Sarg.	Pinaceae	Palani	Native to Himalaya
84	*Polygala sibirica* L.	Polygalaceae	Nilgiri, Palani, Sispara	Native
85	*Polypogon nilgiricus* Kabeer & V.J. Nair	Poaceae	Nilgiri, Palani, Sispara	Endemic
86	*Polytrias indica* (Houtt.) Veldkamp	Poaceae	Nilgiri, Palani, Sispara	Native
87	*Pteridium aquilinum* (L.) Kuhn	Dennstaedtiaceae	Nilgiri, Palani, Sispara	Invasive
88	*Rhododendron nilagiricum* Zenker	Ericaceae	Nilgiri, Palani, Sispara	Endemic
89	*Rubus ellipticus* Sm.	Rosaceae	Nilgiri, Palani, Sispara	Native
90	*Rubus fairholmianus* Gardner	Rosaceae	Nilgiri, Palani, Sispara	Native
91	*Rubus racemosus* Roxb.	Rosaceae	Nilgiri, Sispara	Endemic
92	*Satyrium nepalense* D. Don	Orchidaceae	Nilgiri, Palani, Sispara	Native
93	*Senecio lavandulifolius* Wall. ex DC.	Asteraceae	Nilgiri, Palani, Sispara	Endemic
94	*Solanum viarum* Dunal	Solanaceae	Nilgiri, Palani, Sispara	Invasive
95	*Striga angustifolia* (D. Don) C.J. Saldanha	Orobanchaceae	Nilgiri, Palani, Sispara	Native

96	*Striga asiatica* (L.) Kuntze	Orobanchaceae	Nilgiri, Palani, Sispara	Native
97	*Strobilanthes kunthiana* (Nees) T. Anderson ex Benth.	Acanthaceae	Nilgiri, Palani, Sispara	Endemic
98	*Strobilanthes lanata* Nees	Acanthaceae	Nilgiri, Sispara	Endemic
99	*Strobilanthes wightiana* Nees	Acanthaceae	Nilgiri, Sispara	Endemic
100	*Swertia angustifolia* Buch.-Ham. ex D. Don	Gentianaceae	Nilgiri, Palani, Sispara	Native
101	*Swertia corymbosa* (Griseb.) Fielding & Gardner	Gentianaceae	Nilgiri, Palani, Sispara	Endemic
102	*Taraxacum officinale* F.H. Wigg.	Asteraceae	Nilgiri, Palani, Sispara	Invasive
103	*Themeda sabarimalayana* Sreek. & V.J. Nair	Poaceae	Nilgiri, Palani	Endemic
104	*Themeda tremula* (Nees ex Steud.) Hack.	Poaceae	Nilgiri, Palani, Sispara	Native
105	*Tripogon bromoides* Roth ex Roem. & Schult.	Poaceae	Nilgiri, Palani, Sispara	Native
106	*Tripogon narayanae* Sreek., V.J. Nair & N.C. Nair	Poaceae	Nilgiri, Palani, Sispara	Endemic
107	*Ulex europaeus* L.	Fabaceae	Nilgiri, Palani, Sispara	Invasive
108	*Vaccinium symplocifolium* (D. Don ex G. Don) Alston	Ericaceae	Nilgiri, Palani, Sispara	Native

Abstract

The vegetation in the habitats of the endemic montane grassland bird Nilgiri Pipit at Palani Hills and Nilgiri Hills of southern Western Ghats is delineated in this study. Threats to the habitats of the Nilgiri Pipit by invasive plants species is also discussed.

Key words: endemic, grasses, invasive, Kerala, native, Tamil Nadu, threat

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Inwentaryzacja florystyczna siedlisk zagrożonego ptaka łąkowego świergotka górskiego (*Anthus nilghiriensis* Sharpe) na wzgórzach Palani i Nilgiri na południowych Ghatach Zachodnich w Indiach

Streszczenie

W niniejszym opracowaniu scharakteryzowano roślinność w siedliskach świergotka, endemicznego ptaka łąk górskich, występującego w Palani Hills i Nilgiri Hills w południowych Ghatach Zachodnich. Korelacja między endemicznymi trawami a zagrożonym świergotkiem górskim jest wyjaśniona. Omówiono tu również zagrożenia siedlisk świergotka przez inwazyjne gatunki roślin.

Słowa kluczowe: endemiczny, trawy, inwazyjny, Kerala, native, Tamil Nadu, zagrożenie

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